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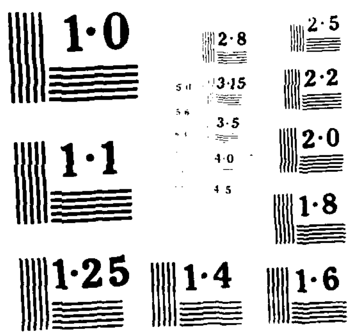
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STUDY PROJECT

COMPUTERS: YESTERDAY, TODAY & TOMORROW

BY

LIEUTENANT COLONEL (P) JOHN J. ROTTY, AG

7 APRIL 1986

US ARMY WAR COLLEGE, CARLISLE BARRACKS, PA 17013

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This project looks at the history, development, and future trends for computer utilization in modern society. The trends and developments are presented to provide the reader with information to understand and then exploit the use of computers and to enhance both personal and professional development. As senior leaders and warfighters it is essential that we understand computer applications. The information contained in this research

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COMPUTERS

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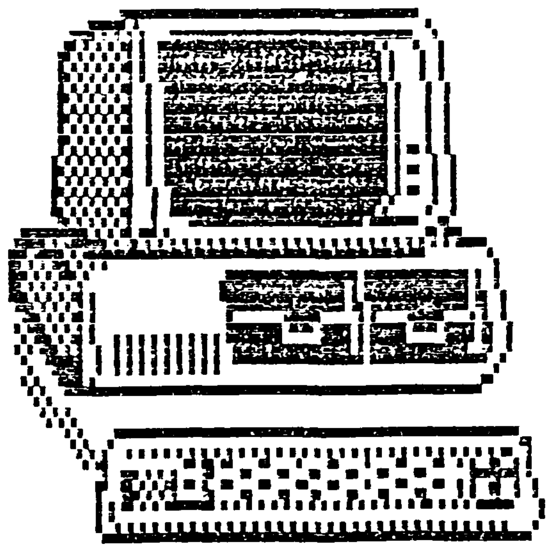

TODAY

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TOMORROW

USAWC MILITARY STUDY PROGRAM PAPER

COMPUTERS: YESTERDAY, TODAY & TOMORROW

AN INDIVIDUAL STUDY PROJECT

by

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7 April 1986

ABSTRACT

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This project looks at the history, development, and future trends for computer utilization in modern society. The trends and developments are presented to provide the reader with information to understand and then exploit the use of computers and to enhance both personal and professional development. As senior leaders and warfighters it is essential that we understand computer applications. The information contained in this research project will provide the reader with the first steps in the process of becoming computer literate.

PREFACE

This individual study project was undertaken to provide the reader with an understanding of computers in layman's terms. The project begins with a look at the historical development of computers and how they function. With that background in place, the study then looks at computer systems software, peripherals or memory devices that are used with computer systems, and a look at the history and development of personal computers. The study would not be complete without reviewing the social impact of computers on society, and a look at the future for computer development and utilization.

The research, preparation, and writing of this study project has proven to be a valuable learning experience for the author. The intent is to share that with the reader, thereby providing a basic understanding of the computer, its operation and use in modern society.

TABLE OF CONTENTS

CHAPTER I

HISTORY OF COMPUTER DEVELOPMENT

From earliest times, man has sought relief from the most menial of his mental and manual chores. Man's mental tasks were one-dimensional, tied to numerical combinations based upon (manual or mental) manipulation of his 10 fingers and/or 10 toes. The boundless energy of man's mind eventually overcame these restrictions. Complex relationships and structures were represented by piles of stones and arrangements of sticks rather than fingers and toes. However, repetitive calculations continued to plague man's progress. In man's quest for relief from these repetitive calculations, he progressed through several scientific stages.

THE ABACUS

Invented more than 4,000 years ago, the abacus is considered by many to have been the world's first digital calculator. It uses beads and positional values to represent quantities. The abacus served as man's primary means of calculating until the 17th century.

PASCAL'S CALCULATOR - 1642

The next significant advance in man's ability to calculate was Blaise Pascal's mathematical digital calculator, designed around the concept of serially connected decimal counting gears. These gears were interconnected in a 10:1 ratio and incremented accordingly so as to be able to carry numbers in decimal relationships.

THE BABBAGE ANALYTICAL ENGINE - 1834

Charles Babbage's analytical engine was the first visualization of a digital computer as we know it today. This device would not only perform arithmetic calculations but would also control itself and feed back answers automatically for more complex computations. It had a memory capable of storing 1,000 numbers of 50 digits each. It would also perform logic decisions and punch answers on cards. The engine used the concept of input, sequential control, internal storage, arithmetic and logic functions, and automatic read out. When we get into modern computer operations you will see that all of these are still standard features.

HOLLERITH PUNCHCARD MACHINE - 1886

In 1886 Dr. Hollerith, a noted statistician, designed and developed the first punch card accounting system. The system included a card punch machine, card sorter and card tabulator. It represented the first electromechanical data processing system. Dr. Hollerith organized a firm to develop his equipment for commercial marketing. That firm became known as IBM in 1924.

AIKEN'S AUTOMATED CALCULATING DEVICE - 1937

In 1937 Professor Howard Aiken of Harvard University developed an electromechanical automatic sequence-controlled calculator. He accomplished this by combining the principles of Dr. Hollerith's punch card processing with the latest in electronic technology. The result, the Mark I, was considered the first automatic computer type machine. It was noted for its extensive use of electromechanical relays.

THE IMPACT OF WORLD WAR II

Aiken's relay computer could not handle World War II requirements because of its slow computing speed. As we look back to the late 1930's we find that three engineers; Konrad Zuse from Germany, Olan Turing from England, and George Stibitz from the United States were all involved in the development of an electronic vs. electromechanical computer. These German, British and American machines all shared a common characteristic: They were the first computers to use the binary system of numbers, the standard internal language of today's digital computers. This led to the development of high speed systems required for World War II processing.

ECKERT AND MAUCHLY'S ENIAC - 1946

The first electronic digital computer to be put into full-scale operation was designed by Drs. J. Presper Eckert and John W. Mauchly. The Electronic Numerical Integrator and Calculator (ENIAC) was built using the technology developed during World War II, along with concepts developed by Dr. John Alanasoff, who also worked on the design of an electronic digital computer at Iowa State University from 1935-1942. This early electronic computer used 18,000 vacuum tubes and could do the work of 1,000 people using calculators.

FIRST GENERATION COMPUTERS

Following the end of World War II, growth was slow in the development of computers. During this period a concept was developed which would allow a computer to program its own actions based upon instructions initially stored in the machine's memory. Using this stored program concept, two

computers were built in 1951. These machines used vacuum tubes for logic circuitry and relied on magnetic tape for bulk storage.

SECOND GENERATION COMPUTERS

The most significant difference between first and second generation computers was their greatly reduced size. This was mainly due to the use of transistors rather than vacuum tubes. Second generation computers had a marked increase in computing speed and machine-produced errors were virtually eliminated through the use of built-in detectors and correction devices.

Along with second generation computers came faster peripheral equipment. High speed printers and card readers along with faster punch card devices greatly increased computer throughput.

THIRD GENERATION COMPUTERS

Third generation computers brought with them increasingly smaller size and compactness. For example, a first generation transistor or resistor, varied from 1/4 to 1/2 inch in size. State of the art technology reduced a dozen circuits into a 1/2-inch-square area. The technology of integrating circuits has advanced rapidly, resulting in both size and cost reductions in computers. Additionally, timesharing, multiprogramming and multiprocessing became widely used in third generation systems. These advances, along with much faster peripheral devices, extensive use of controllers and various software techniques, accounted for a quantum leap forward in computer technology.

CHAPTER II

COMPUTER COMPONENTS AND THEIR FUNCTIONS

A computer system is composed of two major elements: hardware and software. This chapter will review those fundamental elements that are commonly grouped under the category of hardware. Software will be discussed in the following chapter.

Computer or data processing hardware can be divided into three major functional areas; input/output, arithmetic/logic and control (the CPU), and storage.

INPUT/OUTPUT DEVICES

Input devices are used to transfer data from an external source through the control unit and into the central memory of the computer. Output devices are necessary to communicate information to the user. The chapter on Personal Computers will discuss I/O devices in more detail.

CENTRAL PROCESSING UNIT (CPU)

The control unit portion of the CPU is the director of the system. It receives, interprets and issues instructions on how to process data. The control unit coordinates and controls the functions of all other elements of the system.

The arithmetic and logic unit (ALU) is the element that performs the arithmetic operations as well as logical comparisons. This section of the computer is the workhorse and operates under the total direction of the control unit.

STORAGE

Central memory (storage) is the component of the system into which data is entered and held, and from which data may be retrieved. It also holds instructions the control unit uses for manipulating data. In addition to central memory, most computers use additional storage devices to hold data. These devices may consist of rotating magnetic disks, magnetic tape, thin film, optical disks, etc. The CPU transmits data into these storage devices and later retrieves that data for processing. These devices will also be discussed in more detail in a later chapter.

CHAPTER III

SOFTWARE

As noted in the previous chapter, a computer system consists of both hardware and software components. Software consists of a set of commands that manage the computer's operations. Just as there are many types of hardware (CPU's, memory, peripherals), there are many types of software.

Software can be broken out into three major categories: operating systems, programming languages and applications programs. These will be covered in the following three sections.

OPERATING SYSTEMS

An operating system is a collection of programs that allows a computer to supervise its own operations, automatically calling in programs, routines, languages, and data as needed for processing. It consists basically of three elements: control programs, processing programs and data management programs.

The control program provides automatic control of the computer resources. Because of the control programs, there is a minimum of operator intervention.

The processing program consists of language translators, which compile or interpret source and service programs.

The data management programs are used to control the organization and access of data used by programs on the system.

Operating systems are designed to control and extend the processing capability of the computer. Most operating systems for personal computers are disk operating systems (DOS). They control the personal computer and its disk storage operations. This operating system is often referred to as the computer's housekeeping program. More information on these systems will be found in chapter VI on personal computers.

PROGRAMMING LANGUAGES

Programming languages form the primary vehicle for communication with the computer. Without computer languages it would be necessary to design all instructions into the architecture of the system.

There are many types of computer languages and they can be separated into two main categories: low-level languages which are closely related to the actual computer architecture, and higher level languages which more closely resemble the language of the specific application, i.e., arithmetic, algebra, for scientific application and English for business applications.

Low-level languages can be further subdivided into two categories: machine language and assembly language.

MACHINE LANGUAGE

A computer's machine language consists of strings of binary numbers and is the only one the CPU directly understands. An instruction prepared in any machine language is composed of at least two parts. The first part commands the operation; it tells the computer what function to perform. The second part of the instruction is the operand; it tells the computer where to find or store the data or other instructions that are to be manipulated.

ASSEMBLY LANGUAGE

In the early 1950's, mnemonic operation codes and symbolic addressing were developed to simplify the programming process. One of the first steps in improving the program preparation process was to substitute letter symbols--mnemonics--for the numeric machine-language operation codes. Each computer now has a mnemonic code, although the actual symbols used vary among makes and models. Machine language is still used by the computer to process data, but the assembly language first translates the specific operation code symbol into its machine language equivalent. Additional programming improvements have been made which include symbolic addressing, in which the address locations are expressed in symbols rather than numerically.

Programmers no longer assign actual address numbers to symbolic data items, they merely specify where they want the first location to be. From there an assembly language program takes it over, allocating locations for instructions and data.

This assembly language or assembler also enables the computer to convert the programmer's assembly language into its own machine code. A program of instructions written by a programmer in an assembly language is known as a source program. After this source program has been converted into machine code by an assembler it is referred to as an object program. This object program is then used during actual data processing operations.

The key points to remember are that assembly languages or assemblers enable the computer to convert the programmer's assembly language into its own machine code, and that these languages are very efficient to use, but at the same time difficult to program.

HIGHER LEVEL LANGUAGES

To further speed up coding, assembly programs were developed in which a single set of instructions (macro) would produce several lines of machine language code. The development of mnemonic techniques discussed previously and macro instructions, led to the evolution of higher level languages that are often oriented toward a particular class of processing operations. High level languages also have the advantages of being easier to learn than assembly languages, require less time to write, provide better documentation, and are easier to maintain.

As noted previously, a source program written in a high level language must also be translated into machine-usable code. A translator program that performs this operation is called a compiler. An alternative to using a compiler for high level languages translation is often employed with microcomputers. This works as follows. Instead of translating the source program and permanently saving the code, the programmer loads the source program into the computer along with the data to be processed. At this point an interpreter program inside the computer converts each source program statement into machine language as needed during the process. No object code is saved for future use and the next time the instruction is to be used it must once again be interpreted and translated into machine language.

When we look at specific higher level programming languages we find there is no single program to meet all needs. Any programming language can create almost any type of program, including other programming languages. Each programming language has one or more ideal use, as we will see in the next section. They are based upon proficiency time, program development time, execution speed, size of the developed program, nature of the commands and adaptability. These factors will determine which programming languages will be best for the task.

During the past 30 years, more than 200 programming languages have been developed. The following paragraphs will give the reader a quick overview of four of the more commonly used programs today.

BASIC

Beginners All Purpose Symbolic Instruction Code (BASIC) is the most popular interactive language that has wide appeal due to its ease of use. As an interactive language, it permits direct communication between the uses and the computer. Basic is one of the most popular high-level languages used in microcomputer systems and many of the personal computer application programs, including some commercial software products, are written in BASIC. Additionally, BASIC has many powerful features that let the user implement a wide spectrum of applications including business, science, engineering, data management and even computer games.

FORTRAN

The name is derived from FORmula TRANsfer (FORTRAN), which implies simplicity in programming mathematical calculations. FORTRAN is widely used as an introductory language to teach programming and is currently the most widely used language for scientific and engineering applications. This is due to its ease of use and extensive set of math functions. It should be noted that numerous business applications have also been developed in FORTRAN. Many of these are in the accounting field.

COBOL

COmmon Business Oriented Languages (COBOL) is one of the most widely used languages for business data processing applications. The main advantage of COBOL is that it can be written in a quasi-English form that uses business terms. Because of this fact, the logic of COBOL is more easily understood by non-programmers.

PASCAL

Pascal was developed as a language to be conducive to good programming style. As a result, Pascal encourages the writing of disciplined, organized programs that foster increased programmer productivity. It is a block structured language that composes programs that have clean beginnings and endings with program functions clearly spelled out in separate blocks. This makes modification of programs written in Pascal easier since changes made to one block need not affect any of the other blocks.

C

C is one of the latest in the state of the art general purpose programming languages. C's features include: concise expressions, excellent control flow and data structures and a broad range of operations. It is not specialized to any

particular type of application and has proven to be one of the most popular among programmers today. The language was developed by Bill Lobs in 1974 and is used in the popular UNIX operating system which is used at the United States Army War College today for some of their applications.

There are many more programming languages that have applications for computer uses. For further information, refer to the bibliography of this project.

APPLICATIONS SOFTWARE

Applications software (programs) are the vehicles that turn a computer into an operating tool. These programs are made up of instructions written by programmers, generally in high level languages, to perform specific end user requirements. Many users do not recognize the importance of proper applications software selection. This situation is more complicated by the scarcity of specific information about software compatibility and performance.

Chapter VII will provide more information on applications software and its uses.

CHAPTER IV

PERIPHERALS

Most computer systems use a series of different storage elements (peripherals) usually selected for different tasks. Selections are normally based on retrieval speed, storage capacity and storage cost.

Since many computer applications require large amounts of storage, the peripheral system of most computers is divided into two general categories: main storage and auxiliary storage.

Main storage, often called internal or primary storage, is an integral part of the central processor (CPU). All data to be processed by the computer must pass through main storage. Main storage is used to store both instructions and data. The unit must have sufficient capacity to hold not only the program being used, but also the data being processed by the application of that program. Data in main storage becomes especially critical when you consider a loss of power to the CPU results in a loss of all the data in the system at that point in time.

Auxiliary storage, also called secondary storage, is used to supplement the main storage of the computer. There are two types of auxiliary storage: direct access and sequential access. Direct access devices provide immediate access to data in any storage location, i.e., magnetic core, magnetic disk, magnetic drum, etc. Sequential access devices can only access data in the sequence in which it was stored, i.e., magnetic tape or paper tape.

In larger computer systems, programs and data are held in auxiliary storage until called for by the CPU. Whenever this occurs, the CPU directs the transfer of the specified information into the assigned locations in central memory for processing. After processing is completed, the processed results are sent back to the auxiliary storage unit.

SECONDARY STORAGE MEDIUMS

Magnetic tape is a popular storage medium for large files that are sequentially accessed and processed. Magnetic tape has a high density (over 6,000 characters per inch). Thus it is possible to store over 100 million characters on a single 10-1/2" reel of tape for a cost of less than $20.00.

A magnetic disk is a round platter coated with a magnetizable recording material. It can be used for either sequential or direct access processing. Magnetic disks come in different diameters differing in size from 14" to 3-1/2". The smaller sizes normally are used on personal computers. These disks can be portable or permanently mounted in the storage drives usually called disk drives. They can be made of rigid metal or flexible plastic.

Since the majority of computers to be used by War College students will use magnetic disks for storage, a more detailed understanding of this storage and access process is required. The next few paragraphs will provide that information.

Data is stored on the magnetic disk in a number of concentric circles called tracks. These tracks begin at the outer edge of the disk and continue toward the center of the disk. Each track has a designated number. Data is accessed from the disk by a programed instruction that moves the access arm to the directory on the disk that contains the desired information.

A motor rotates the disk at a constant rate of speed. Data is recorded on the tracks of the spinning surface and read from that surface by one or more of the read/write heads. If a floppy disk is used, which is the case for most personal computers, the head is in contact with the disk. If hard disks (metal) are used, the head(s) float on a cushion of air (fly) a few microinches above the surface.

The average access time for most hard disk storage systems is between 10 & 100 milliseconds. For floppy-disk systems, access time ranges between 70 and 600 milliseconds. Most disk drives have a single read/write head for each disk surface. Some of the faster hard-disk systems have either a fixed head for each track of surface or use multiple heads on each movable access arm to service a number of adjacent tracks. A fixed head-per-track device has no seek time delay and multiple heads reduce the average length of horizontal movement of the access arm and thus decreases seek time.

To complete the review of secondary storage, three more devices will be briefly discussed: ram disks, optical disks and tape strips.

Random Access Memory (RAM) disk storage is used in personal computers. A block of semiconductor chips (RAM chips) are used to simulate a disk. A RAM disk is not really a disk but a bank of RAM chips set up to look like a disk in the computer. RAM disks offer the advantage of high speed but lose their content when power is removed.

Optical disks use a laser recording technology to permanently store data on the medium. It is similar to the technology used on video disks. The storage density of optical disks is enormous, the storage cost per bit very low, and access time is very fast. A single optical disk has the potential to store the contents of a library of several thousand volumes. One small and inexpensive disk will be able to replace 25 reels of magnetic tape and access to data will be in the milisecond range. As a storage medium, optical disks have one serious drawback; once the data is recorded on the optical disk it is permanent and cannot be changed.

The objective of tape strip devices is to combine the magnetic tape advantage of low cost and high storage capacity with the advantages of direct record accessibility. This storage medium may best be described as a length of flexible plastic material upon which short strips of magnetic tape have been mounted. The strips are then placed in cartridges which are loaded into storage devices which are on-line with the CPU. These mass storage devices use the same read/write techniques as those used for magnetic tape.

CHAPTER V

DATA COMMUNICATIONS AND DATA PROCESSING NETWORK

Data communications and network processing are becoming an increasingly integral part of computer operations in society today. This chapter will review the process for data transmission, how transmission channels work and the kinds of organizations that use these channels, and for what purposes. This is an extremely complex subject and only the highlights will be addressed.

Data communications refers to the means and methods by which data is transferred between processing locations. It generally involves on-line terminals that provide a direct link between the processing location and the CPU.

In a simple data communications system, terminals are linked with a central processor to provide input data and receive output information. Interface elements are used to bridge the different I/O devices and CPU's. A variety of data transmission channels are used to transmit data. These will be discussed in the following sections.

The first device is the MODEM. A MODEM is a MODulation DEModulation unit that converts the discrete stream of digital on-off pulses used by computing equipment into the type of continuously variable analog wave patterns that are used to transmit the human voice. Since digital impulses cannot effectively travel any distance over a transmission network designed for voice communication, a MODEM is required to modulate or convert the digital pulses into analog wave patterns when telephone lines are used to transmit data. A second MODEM is needed at the receiving end to demodulate or receive the analog data from the transmitted signal.

Data transmission channels used to carry data from one location to another are classified into three categories: narrowband, voiceband and broadband. The wider the band of the channel the more data it can transmit. Telegraph lines, for example, are narrow band channels and their transmission rate is slow, from about 5-30 characters-per-second (CPS). Standard telephone lines are voiceband channels and can transmit up to 1,000 CPS. Broadband channels are used when requirements for large volumes of data must be handled at high speed. These channels have the capacity to transmit up to 100,000 CPS.

There are three different types of transmission circuits available: a simplex circuit which permits the flow of data in one direction only, a half duplex circuit which can

alternately send and receive data, and a full duplex circuit which can simultaneously transmit and receive data.

With this background we are now prepared to look at the complex coordination required for large computing/ communications networks and data processing networks. Such a network may have hundreds of terminals and many small communications processors located at dozens of dispersed sites. These sites, in turn, are linked by different channels to large host computers.

Communications processors (typically mini or microcomputers) are used by network designers for efficient data flow at the lowest cost. These processors are used for 3 purposes.

The remote concentration of messages to reduce transmission cost. This is accomplished by receiving terminal input from many low-speed lines and then concentrating and transmitting a compressed and smooth stream of data on high-speed or more efficient lines.

Message switches which receive and analyze data from points in the network, determine the destination and proper routing, and then forward the messages to other network locations.

Front-end processing which is designed to relieve the main computer of functions required to interact with and control the communications networks.

As we move into the future, we can expect to become more and more involved with computers and local-area networks. In many organizations, data is also transmitted between computers, terminals, wordprocessing stations, and other devices that are located within a compact area, such as an office building or school campus. The communications systems used to link these nearby devices are referred to as local-area networks (LAN's). LAN's are classified as high speed when used with mainframes, medium speed when used with mini-computers and low-speed when used with personal computers.

There are other concepts/systems which warrant review. These cover systems applications as they relate to both business and military operations now and in the future. A brief review of some of these follows.

REAL TIME PROCESSING SYSTEMS

A real time processing system is interactive with an ongoing activity and produces information quickly enough to be useful in controlling that activity. The words real time describe a direct-access or on-line processing system which processes immediately all input data, updates that data and provides the output for action to the user.

TIMESHARING AND REMOTE COMPUTER SERVICE SYSTEMS

Timesharing is a general term used to describe a processing system with a number of independent, relatively low speed, on-line, and simultaneously usable stations; each of these stations have direct access to the CPU. The speed of modern computer systems and the use of multiprogramming allows the CPU to switch from one station to another, and to do part of each job in an allocated time period until the job is completed.

Today a number of organizations sell timesharing and remote computing services. These organizations install terminals in customer offices and then use telecommunications channels to link these terminals to their central processors or mainframe. It should be noted that personal computers can also be linked to the processor for timesharing purposes. This is currently being done at many military and civilian organizations and we will see greatly expanded use of these concepts as we move into the future.

Let's take a look at three examples of systems that are in use today in both the business and industrial settings.

Electronic mail and message systems are used by both military and civilian organizations to transmit, inter and intraorganizational messages using telecommunications lines. Network computers are used to temporarily store and route the messages.

Banks communicate with each other and use telecommunications networks to transfer funds. One of the latest additions is a bank at home system, which allows the customer to conduct business with the bank from his/her home.

Data base retrieval systems allow computer users to access news, weather and stock market information, electronic shipping catalogs, bulletin boards, classified advertising services and libraries. The types of information accessible is growing rapidly and will be a key source of saving manpower in the future.

Additionally, many professionals are now doing some of their work at home using personal computers and word processors. These results are then forwarded electronically to the work location using their modems.

DISTRIBUTED DATA PROCESSING NETWORK

When one or two processors handle the workload of all outlying terminals, we still use the term timesharing. However, when many geographically dispersed and independent computer systems are connected by a telecommunications

network and when messages, processing tasks, programs, data and other resources are transmitted between cooperating processors and terminals, we move into the world of distributed data processing (DDP) networks.

Some advantages of sharing computer resources through DDP include the availability of sophisticated computers and large libraries, the help of computer/communications specialists, and the availability of multiprocessors that permit peak-load sharing and backup. Additionally, network resources may provide answers to unusual problems and telecommunications costs may be lower when local processing is handled by smaller, on-site computers.

CHAPTER VI

THE PERSONAL COMPUTER

The previous chapters have reviewed the history, operation, and use of computers with an emphasis toward larger systems. This basic background is necessary to lay the groundwork for this important chapter on the personal computer. Here we will look at personal computer development, characteristics, standards, use and application packages.

BACKGROUND

A personal computer (PC) is the smallest of the general-purpose processing systems that have the capability to execute the program instructions to perform a wide variety of tasks. A PC has all the functional elements found in any larger system. It is organized to perform the input, storage, arithmetic, logic, control, and output functions. Some complete microcomputer CPU's are packaged into a single chip, however, most personal computers are larger and employ several chips. A miocroprocessor chip, for example, performs the arithmetic-logic and control functions. Several random access (RAM) chips are available to handle the primary storage functions. Additionally read-only (ROM) chips may be used to store preprogrammed data or instructions. Most PC's are self contained units and are designed to be used by one person at a time.

PERSONAL COMPUTER DEVELOPMENT

In 1969 two engineers from Data Point Corporation developed a model of a microprocessor chip which was offered to Texas Instruments and Intel Corporation for follow-on development. In 1970 engineers from Intel developed and built the first microprocessor chip with a limited capacity.

The next step in the development process came in 1974 with the introduction of the 8-bit microprocessor. A bit is common computerese shorthand for a binary digit, a 1 or 0. The most frequent grouping of bits is 8, which is the number needed to express a byte, or one character. This 8-bit microprocessor led to the development of the first personal size microcomputer system, the ALTARI 8800. Although the ALTARI model was the first entry into the market, the dominant machines of the 1970's included several versions of the Apple II and the TRS-80.

As the 1980's began, lower cost systems intended primarily for home use, were marketed to the consumer. There were more than 150 manufacturers introducing desk top models for

professional, business and other organizational use during the early 80's. As competition for market share increased, a number of these manufacturers disappeared from the marketplace.

Following these events, a new generation of PC models was introduced. These models were built around a 16-bit microprocessor, a processor working with two bytes at a time. The IBM PC family of models are by far the most popular systems with this architecture. Because of the wealth of software developed for the IBM systems, designers of many competitive brands of PC's have elected to use the same microprocessor and operating instructions. Now let's take a look at PC components and their characteristics.

CPU CHARACTERISTICS

The central processing unit or microprocessor in a personal computer is composed of two components: the control unit (CU) and the arithmetic and logic unit (ALU). The ALU performs arithmetic and logic operations on the data passing through it. Typical arithmetic functions include addition and subtraction. Typical logic functions include and/or, go/no analysis. The main function of the control unit is to obtain, decode, and execute the successive instructions of a program stored in memory. The control unit sequences the operation of the entire system. In particular it generates and manages the control signals necessary to synchronize operations, as well as the flow of program instructions and data within the ALU.

CPU's process data via an 8, 16, or 32 bit microprocessor. The 8-bit microprocessor is limited in that it can only work with a maximum of 65,536 (64k) bytes of memory at one time. This is roughly 25 pages of typewritten data or one large accounting spreadsheet. For today's applications more computing power is required. This led to the 16-bit machine.

The 16-bit microprocessor can address between 262,144 (256k) and 16 million bytes of memory. It also shares the work of addressing memory and executing programs between two internally separated units. These microprocessors can work at rates 2-15 times faster than their 8-bit counterparts. It is important to understand these differences when you are looking at CPU operations.

As we enter the mid 80's we are now looking to the next generation of personal computers. These systems will use 32-bit processing technology and have the same power as many of the smaller mainframes in use today.

CHARACTERISTICS OF PERIPHERALS

Virtually all personal computers include an operator keyboard for data entry. The keyboard of the PC is based upon the QWERTY system, i.e., the standard typewriter keyboard. Some keyboards are permanently housed with the CPU and display screen while others are detachable. Some have special function keys and others separate numeric pads. It is very important to understand the keyboard system since many software applications are keyed to its style.

Magnetic tape cassette players and/or floppy disks are used as storage devices from which data is received for processing and to which processed data is sent. The major peripheral advances have been in the disk storage area. When the PC first came out it offered the user a mini-floppy 5-1/4" disk drive that would store 160k on a single side. Today advanced mini-floppy drives can hold up to 1.2 megabytes (1.2 million) bytes of data on a double sided disk. Additionally, hard or fixed disks are available which have a capacity equivalent to 30 double sided 5-1/4" floppy disks. A hard disk is also faster, since more information is stored on each track, the access arm moves faster, and the information is read or written at a higher rate of speed because the disk rotates ten times faster than a floppy drive. There are also 8" and 3-1/2" disks which are used by some personal computers. On-line secondary storage can also be provided by a RAM disk. Again, a RAM disk is a bank of RAM chips set up to look like a disk drive to a PC.

Visual display screens and printers are the most common output devices used with a PC system. A cathode ray tube (CRT) is used in most PC display monitors. This display of data permits rapid communication between the computer and the operator. It is also used for visual editing of data or text. The characteristics of the CRT display will determine its capability to display some of the latest software. It is very important to understand your needs when you select a display for a PC system.

Printers can be very sensitive devices. A printer from one manufacturer may not function with a computer from another manufacturer. Prior to selecting a printer insure the systems are compatible from both the software and hardware perspective. Software programs that include a print data capability may not work with a particular printer unless the software contains specific programs, called drivers, to match the computer with the printer. From the hardware perspective the systems must have compatible interface connections to insure the data can transfer from the computer to the printer. These connections will either be parallel or serial.

A parallel interface is one that moves 8 or more bits of information at one time. Many of todays PC's have a built-in Centronics parallel printer port (another de-facto standard). If both the computer and the printer the user selects have compatible ports, then a hardware link-up can be made.

Unlike the parallel interface that uses eight wires to transmit all eight bits at the same time, a serial interface transfers the bits in sequence over a single wire. When a PC uses a serial interface port, the 8-bit bytes produced by the PC are lined up into a single stream for serial transmission.

OPERATING SYSTEM STANDARDS

Chapter 3 defined an operating system as an overall set of program instructions needed to manage and coordinate the various parts of the computer system. In the world of PC's, official operating system standards do not exist. However, there are numerous proprietary operating systems just as there are many hardware standards.

In the 8-bit market CP/M-80 and Apple DOS are the de facto standards. CPM/80 was developed by Digital Research and is used in the systems using Z-80 and 8080 microprocessors. Apple DOS was developed by Apple computer for their Apple II systems.

The leading 16-bit machines of the mid-1980's are those designed around the Intel 8088 and 8086 microprocessors. The de facto standard for these machines is MS-DOS developed by Microsoft, Inc. The popularity of MS-DOS stems from the fact that it is the one IBM selected for use with its PC's.

COMPUTER SYSTEMS FOR THE HOME AND OFFICE

PC systems found in homes are generally used to entertain, educate and increase personal productivity. Prices range from less than \$100 to about \$1,500 today. The least expensive models have limited keyboards and use a TV set to display output.

The cost of additional hardware and software will raise the price of business systems into the \$2,000-\$10,000 range. Better keyboards, larger primary storage sections, significant on-line secondary storage, easy-to-read display screens and letter quality printers are needed with these systems to perform serious word processing, spreadsheet calculating and data base management.

Today much of the best organizational and professional software is being written for the IBM type PC's and other 16-bit systems using the MS-DOS operating system. Some of the most popular programs like LOTUS 1-2-3 and Symphony (see

following software section) integrate several functions into a single software package.

As noted above, the operating system software controls the overall operation of the computer. Applications programs perform particular tasks.

Today there are more than 5,000 applications software products in the marketplace. One publication, available at the War College, lists all of these products and their functions. It is the Datapro Directory of Microcomputer Software. The publication not only breaks the software products into 24 major applications categories, it also provides guidance to follow in selecting applications software. The bibliography lists a number of publications that can be used as resources for assistance in software selection.

With the availability of more than 5,000 software products, it becomes extremely difficult to determine categories and products for consideration. The October 1985 issue of PC World rated the top software packages by category. Listed below are those that ranked number one in each category. For more information on each product, please refer to the publications listed above and those in the bibliography.

TOP RATED SOFTWARE BY CATEGORY

Type of Application	Product and Manufacturer
Spreadsheet	1-2-3 Lotus Development Corp.
Data Base - Major	d-Base III Ashton - Tate
Word Processing	Wordstar Micropro International Corp.
Communications	Crosstalk XVI Microstuf, Inc.
Graphics - Business	1-2-3 Lotus Development Corp.
Integrated	Symphony Lotus Development Corp.
Accounting	Peachtree's Business Accounting System Peachtree Software, Inc.
Project Management	Harvard Project Manager Harvard Software, Inc.

Type of Application	Product and Manufacturer
Investment (2)	Dow Jones Market Manager Plus Teleware & Dow Jones Inc. and Andrew Tobias' Managing Your Money MECA
Financial Modeling	1-2-3 Lotus Development Corp.
Tax Preparation	Tax Preparer Howardsoft
Data Base - Index File	PFS: File Software Publishing Corp.
Decision Making	1-2-3 Lotus Development Corp.
Desktop Manager	Sidekick Borland International Inc.
Education	Spinnaker Educational Games Spinnaker Software
Training	ATI's Training Power Series American Training Intl.
Language	Turbo Pascal Borland International Inc.
Personal Management	Andrew Tobias Managing Your Money MECA
Games	Microsoft Flight Simulator Microsoft Corp.
Graphics - Drawing	PC - Draw Micrografx, Inc.
Utilities	Norton Utilities Peter Norton Computing, Inc.
Applications Integrator	Top View IBM

CHAPTER VII

SOCIAL IMPACT - BENEFITS AND DANGERS

This is an extremely complex subject about which thousands of articles and books have been written. This chapter will only scratch the surface in order to present the reader with a snapshot of the impact the computer has had on society. It is intended to serve as food for thought.

Many people are and will be required to manage and operate computer systems used in today's organizational environment. Those not directly involved in the process will benefit from the goods and services provided by computer using organizations; for example.

Top level managers are using project management, data base management, and management information systems in their strategy planning and in reducing some of the uncertainty in their decision making process. Middle managers are freed from some of their paperwork and reporting tasks by the computer. This enables them to devote more time to the people management process.

Scientists and engineers are using computers in research efforts and for the employment of computer modeling to evaluate alternatives. Sales personnel now have access to real time inventory data to assist in their sales efforts. Clerical employees are relieved of many repetitive and routine tasks by computers and word processors.

Now that we have a perspective from the individual viewpoint, what are the organizational benefits? Many people fail to realize the extent to which government and business have avoided waste and improved efficiency through the use of computers. This improvement in productivity has provided real industrial growth from which we all benefit.

Computers have improved the quality of products we receive. For example, microprocessors are now installed in automobiles to provide more efficient means for controlling engine fuel mixture, ignition timing and exhaust emission. Additionally, businesses also use computers to improve services they provide to customers. Computer processing techniques make possible shorter waiting lines at ticket offices and reservation desks, faster access to customer inquiries, and inventory control in retail outlets which insure popular items will be in stock.

Applications can also be seen in the medical field where computers provide real time medical histories, more accurate disease detection and identification, consistent physiological monitoring and better control of laboratory list results and pharmacy services.

But what about the opposite end of the scale. People have seen their jobs disappear when new computer systems have been installed and today others are being threatened with job loss because of computer based changes, i.e., robots in the manufacturing, auto and steel industries. Because of this threat many business operations are beginning to establish retraining programs to assist their employees in transitioning to other occupations. Additionally, many companies are communicating their plans to their employees up front and working with them to insure the plan is understood and supported to the maximum extent possible. In my opinion we have come a long way in this area but still have a long way to go.

Questionable data processing practices have had adverse effects on people's lives and their records. Proper controls are lacking in some data originating and recording procedures; data has been gathered about people where there is no value or need to know; it may be gathered inaccurately, incompletely, and/or used in ways not originally intended.

A few examples will help to demonstrate how computer systems can potentially create adverse impacts on people and their lives. Mailing lists giving details about people are regularly sold to both private and public organizations. Thousands of law enforcement agencies, banks, employment agencies and credit companies have easy access to networks containing information on millions of people, you and me. This has caused many people to behave differently and with increasing awareness that what you say and do may become part of some computer record; a record over which we have no control and may not even know exists.

CHAPTER VIII

TOMORROW'S COMPUTERS

This last chapter will look at what we can expect to see in both the hardware and software fields as we move forward into the late 80's and early 90's. Please keep in mind that with the rapid advances in technology, it is nearly impossible to keep current with the state of the art, and technology today will not be the same as technology tomorrow.

Numerous changes can be expected in I/O devices and central processors. By the late 1980's we can expect to see many stand alone data entry systems replaced by multifunction on-line terminals that will perform both word processing and data processing functions. Optical Character Reader (OCR) equipment will be refined and it will no longer be necessary to rekey data captured by nonelectronic data entry devices, such as typewriters. OCR's will take the data directly from the typewriter page. Speech recognition will become the preferred means of supplying input data into future computers. IBM now has some basic applications out in this field.

In the secondary storage area, new direct access devices are being developed that will provide virtually unlimited on-line secondary storage at a fraction of today's cost. Approaches will be in the field of perpendicular recording techniques that will significantly increase the density of storage on a given disk surface. Laser technology will also be used for the storage of data on optical disks. As mentioned in a previous chapter, this already exists in development form. Also, in the next decade many permanent archives now stored on microfilm and magnetic tape will be placed on optical disks.

Much of the growth in on-line terminals is expected to be in the categories of typewriter-like terminals (teleprinters), intelligent visual display terminals, with graphics capability which can be controlled by touch, and more sophisticated specialty terminals.

Many of the typewriters of the late 1980's will have undergone several changes, many of which are in process today. They will be intelligent portable devices containing microprocessors and memory chips. They will be used by organizations to meet both word processing and data processing needs.

Intelligent visual display terminals will also be used for word processing and data entry applications. The use of personal computers as executive work stations will expand dramatically by 1990. This will come with the advent of specialized integrated applications software and expert systems programs.

What about central processors (CPU's)? In CPU's we will see substantial reductions in the size of electronic circuitry. Many of tomorrow's microprocessor chips will be 32-bit devices with the processing capability of some current mainframe models. By 1990 millions of bytes of high speed storage will be fabricated into a single microprocessor. Personal computers employing the chips will be able to use the same powerful instructions as are now used by many present-day mainframe models.

Tomorrow's computers will also achieve higher speed through the use of new architecture. Most of today's computers have single control, primary storage, and arithmetic-logic sections. This design approach has been somewhat the same since the 1940's. Scientists are now working to produce smarter, faster and cheaper alternative designs. This will be enhanced by new computer based design automation systems that will allow customers to select the exact combination of computer components (logic gates, storage components, microprocessors) from a library of standard cells. The computer will then be fabricated to the customer's specifications.

The development of software will continue to be slower, more expensive and more difficult, because software functions will continue to be more complex than operations performed by hardware. The total cost trends for information systems will encourage the replacement of expensive software with cheaper hardware where possible. Part of this will be accomplished through the use of microprograms. These programs which will be stored in ROM devices (also called stored logic or firmware) will analyze and decode instructions into elementary operations that a particular CPU is designed to execute. Vendors and users will increasingly fuse their most important microprograms into ROM chips, in effect converting hardware to software.

Existing languages such as BASIC, COBOL, FORTRAN, etc., will be enhanced and improved to accommodate structural programming. New program development aids, such as structural programming, will result in higher programmer productivity, shorter program development time and more understandable program needs. The trend toward the use of packaged programs will continue to accelerate. The 1985 Personal Computer Digest (see bibliography) lists 75 separate programming packages that are available today.

As we move forward into the future computer use, all levels of computer use from supercomputers to PC's, will result in greater freedom, more efficiency, enhanced productivity, and a more human and personal society. The benefits to be obtained from computers will far outweigh any temporary difficulties and inconveniences. Society's use of computers will lead to an increased standard of living, shorter work weeks, and more efficiently managed operations.

If you are not computer literate, or familiar with computer concepts and operations, now is the time! The references listed in the following bibliography provide a good starting point for becoming computer literate.

Are you ready to become a player in the computer age?

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